ATNP/WG2-WP/
10 October 1994

AERONAUTICAL TELECOMMUNICATIONS NETWORK PANEL

Working Group Two

San Diego 17.10.94-28.10.94

User Requirements Derived from the ATN Manual

Presented By Eike Meyenberg and Henk Hof

Prepared by Tony Whyman

SUMMARY

The preparation of the ATN Requirements Database identified, in the ATN Manual, many possible User Requirements. These have now been analysed and reformulated in a style that properly brings out the requirement. This paper contains both the ATN Manual text that was identified as representing User Requirements, and their reformulation. The Working Group is recommended to review this work and consider whether it should be referred to Working Group and/or put forward for inclusion in the draft ATN SARPs.

DOCUMENT CONTROL LOG

SECTION	DATE	REV. NO.	REASON FOR CHANGE OR REFERENCE TO CHANGE
	10-Oct-94	Issue 1.0	

TABLE OF CONTENTS

1 Introduction

1.1 Background

During the development of the ATN Requirements Database, a number of items where found that appeared to be reflecting user requirements rather than being requirements on the implementors or operators of the future ATN. These "perceived user requirements" are reproduced in Appendix A, as a classified list of User Requirements.

However, many if not most of these perceived user requirements are not formulated as proper user requirements.

1.2 Scope

The objective of this paper is to take these perceived user requirements and to reformulate them as a consistent set of properly stated User Requirements. They may then be reviewed by members of the ATN Panel and a decision made as to their correctness, appropriateness and completeness.

2. Preparation of User Requirements List

The work started with the "raw" list. Each entry in the list was inspected and, where appropriate, reformulated as a requirement statement, containing keywords such as "shall" and "should". List entries that appeared to contain two or more actual requirements were split up, while others, which appeared to overlap or otherwise address the same subject, were combined. Each identified user requirement was then given a unique reference number. The resulting table is given in section 3 of this paper.

This process has resulted in the identification of sixty five perceived User Requirements which the ATN Manual believes it is addressing. It should be noted that these requirements are not necessarily complete or guaranteed to be appropriate. Further analysis is required for this to be determined. In this context, the reader's attention is drawn to UR57. The formulation of this requirement reflects the fact that the ATN Manual addresses performance and other QoS requirements, but does not specify a target for such requirements.

Not all the User Requirements listed in appendix A are addressed in section 3. "C2 t 0180" is believed to be a correct requirement, but not one that can be addressed by the ATN and is hence identified as "out of scope". "C5 t 0130" and "C5 t 0140" are viewed as "not applicable" as they are not user requirements, but are rather consequences of the ATN architecture.

The list in section 3 now requires review and comment, with the objective of identifying a complete set of User Requirements for the ATN. Furthermore, it should be noted that, since this paper was prepared, a review of the ATN Requirements Database by the EurATN consortium has identified a possible further fifty possible User Requirements. These will need to be analysed and possibly incorporated in a later version of this paper.

3. ATN User Requirements

	Mark-up Reference	User Requirement
UR1	c1 t 0010 -c1 t 0050	In order to fully utilise automated air traffic management (ATM) systems, a global data networking infrastructure shall be implemented in order to support the internetworking of computer systems operating in fixed ground-based and mobile aircraft-based locations.
UR2	c2 t 0040	The operational requirements for a future ATS system should be developed on the basis of a framework of an operational ATS concept. The operational requirements will allow the definition of a detailed functional specification of the ATC system, identifying the necessary ATS functions with related aeronautical applications.
UR3	c2 t 0080	Four aeronautical user groups shall be supported by the ATN: Administrative Users, Operational Users, Airline Passengers and Network Managers.
UR4	c2 t 0080	Administrative and technical provisions shall be provided to inhibit one or more user groups from gaining access to certain subnetworks. For example, the SSR Mode S subnetwork will only carry communications related to safety and regularity of flight.
UR5	c2 t 0060	The international aviation community shall adhere to the separation of communication functions as specified in the Open Systems Interconnection (OSI) Reference Model developed by the International Organisation for Standardisation (ISO).
UR6	c2 t 0170	The ATN shall ensure interoperability and support the exchange of data between users while preserving the semantics of the data.
UR7	c2 t 0190	The various ATC components of the over-all systems shall be designed to work together effectively to ensure a homogeneous, continuous and efficient service to the user from take-off to landing, by implementing ICAO and other International standards in order to provide for interoperability and consistency in operations across national boundaries.
UR8	c2 t 0200	The realisation of a system capable of satisfying the above principles shall include the adaptation of existing procedures and facilities as well as the development of new ones.
UR9	C2 t 0210, c2 t 0220	In the ground environment, the ATN shall support improved handling and transfer of information between operators, aircraft and ATC centres
UR10	C2 t 0210, c2 t 0230	In the ground environment, the ATN shall support improved and more accurate planning, including use of improved weather information;

UR11	C2 t 0210, c2 t 0240	In the ground environment, the ATN shall support an improvement in conflict detection and resolution;
UR12	C2 t 0210, c2 t 0250	In the ground environment, the ATN shall support an improvement in the ability to take advantage of the improved navigation accuracy in four dimensions of modern aircraft;
UR13	C2 t 0210, c2 t 0260	In the ground environment, the ATN shall support improved accommodation of a flight's preferred profile in all phases of flight, based on operator's objectives.
UR14	c2 t 0270, c2 t 0280	The ATN shall be implemented by means of an evolutionary process;
UR15	c2 t 0270, c2 t 0290	Pilots and air traffic controllers shall be kept involved in the ATC process;
UR16	c2 t 0270, c2 t 0300	The new system should not be overly sensitive to random disturbances, such as outages, emergencies, errors in forecasting, etc.;
UR17	c2 t 0270, c2 t 0310	Improvements in weather forecasting should not themselves delay other improvements in over-all system performance;
UR18	c2 t 0270, c2 t 0320	The ATN shall be designed to accommodate normal peak traffic demands
UR19	c2 t 0270, c2 t 0320	The ATN should be easily expanded to meet anticipated future growth
UR20	c2 t 0420	Because of the differences in the level of air traffic management in the various parts of the world, and the variety of factors that influence transition to the future CNS system, an evolutionary development of air navigation for international civil aviation should be planned for implementation over the next 25 years.
UR21	c2 t 0560	AOC functions shall interface with the aircraft via adequate air-ground communications (voice and data), either through cockpit crew intervention or directly with some airborne sensors and systems (after data verification by the cockpit crew) such as flight management systems (FMS) or digital flight data acquisition unit (DFDAU) for functions such as: a) FMS operational data base update on: 1) flight plan data; 2) load and balance data; 3) certain weather data; and b) DFDAU recording of/reporting on: 1) engine health monitoring; 2) fuel flow/status/requirements; etc.
UR22	c2 t 0600	The ATN shall provide the same standardised set of rules to applications, in order to ensure that all messages are delivered as efficiently as possible and in the correct order of priority.

UR23	c2 t 0720	The ATN shall determine the transfer sequence of the provided end-user messages/files, on the basis of required priority (QOS parameter).
UR24	c2 t 0730	Data Transfer Priority shall be specified on a per transport connection basis and determined during the connection establishment phase.
UR25	c2 t 0740	Two types of priorities shall be distinguished: static priority and dynamic priority
UR26	c2 t 0750	Static priority shall be related to the type of information that has to be transferred via the ATN, and shall have the same semantics as with other communications networks. Article 51 of the ITU Radio Regulations gives the order of priority for ten information categories in the aeronautical mobile service and aeronautical mobile satellite service as follows: 1 Distress calls, distress messages and distress traffic. 2 Communications preceded by the urgency signal 3 Communications relating to radio direction-finding 4 Flight safety message. 5 Meteorological messages. 6 Flight regularity messages. 7 Messages relating to the application of the United Nations Charter. 8 Government messages for which priority has been expressly requested. 9 Service communication relating to the working of the telecommunication service or to communications previously exchanged. 10 Other aeronautical communications.
UR27	c2 t 0880	Dynamic priority shall be related to the context in which information is transferred. For example, it is possible that in a short term conflict alert situation a heading instruction message (if that results in better resolution) has a higher priority than in a normal situation.
UR28	c2 t 0870	All the links in the communication network shall be able to determine and to provide the communication service related to the required priority.
UR29	c2 t 1020 - 1060	The use of the QOS parameters plus the network operating assumptions listed below shall permit the end user to be unaware of the particular delivery method(s) used by the ATN to effect data transfer. 1. messages of arbitrary length may be transferred by the ATN; 2. the ATN connection mode Transport Service delivers data in a reliable manner. The user can assume that once the data is accepted by the ATN it will be delivered, unless explicit connection loss is indicated 3. The ATN maintains dynamic routing tables which reflect the current connectivity status, and which it uses to determine the transfer route

		4. the ATN only requires address information, the end-user data and the specified QOS parameters to perform its functions.
UR30	c2 t 1040	The user shall be informed if delivery of previously accepted data is not possible
UR31	c3 t 0060	In order to realise the advantages of an internetwork architecture, techniques for transfer of messages among participating subnetworks shall be independent of protocols and addressing schemes used by any one participating subnetwork.
UR32	c3 t 0070	ATN subnetworks shall be interconnected via internetwork routers observing common internetworking conventions and standards.
UR33	c3 t 0090	ATN routers shall utilise a common internetwork protocol standard, including a common definition of QOS parameters;
UR34	c3 t 0100	ATN routers shall exchange routing information using a common routing information exchange protocol standard;
UR35	c3 t 0110	ATN routers shall utilise a common global network addressing standard;
UR36	c3 t 0120	ATN subnetworks shall carry the internet protocol, routing protocol and global addressing formats between adjacent routers in a transparent fashion.
UR37	c3 t 0170	The ISOPA demands that a uniform level of network service be presented to all transport layer processes at this boundary; when applied to the ATN, this requires that a single network layer service interface shall be adopted throughout the ATN, supported by a common internetwork protocol.
UR38	c3 t 0430	The ATNPA shall be designed to employ any subnetwork technology capable of code and byte independent delivery of data as a constituent subnetwork.
UR39	c3 t 0440, c3 t 0450, c5 t 0150	ATN subnetworks shall provide, either the connectionless-mode subnetwork service, or a connection-mode subnetwork service, utilised through the implementation of the appropriate convergence function.
UR40	c3 t 0580	The interconnected ATN host computers and routers administered by international authorities for aeronautical data communication shall comprise the ATN common domain. The ATN common domain encompasses all data communication service end users associated with the international civil aviation environment.
UR41	c3 t 0780	The ATN shall provide for the minimisation of routing information transfer between administrative/routing domains at the inter-domain level, and between routing areas at the intra-domain level

UR42	c3 t 1050	The ATN subnetwork sublayer shall support the transparent transfer of NPDUs between adjacent internetwork entities. This includes the transparent transfer of global addresses and quality of service information, as well as user data.
UR43	c3 t 1070	The subnetwork interface to the internet (i.e. router) shall occur within the network layer; thus control information for the data link and physical layers is not passed from subnetwork to subnetwork. Hence, the subnetwork may utilise non-conforming protocols within these layers while maintaining ISOPA conformance within the network layer;
UR44	c3 t 1080	ATN subnetworks shall not place restrictions on the form or content of the higher layer headers, but shall simply transfer the control information for these layers without modification;
UR45	c3 t 1090	ATN subnetworks shall be able to carry ISO networkPCI for evaluation by each intervening router (i.e. intermediate system);
UR46	c3 t 1100	ATN subnetworks shall transparently transfer standard global network address (i.e. ISO NSAP) and quality of service information, for evaluation by each intervening router.
UR47	c4 t 0010	The ATN shall be able to function such that each participating administration and service provider can operate ATN Routing Domains, and interconnect, without requiring that some administrations and service providers are more special than others.
UR48	c4 t 0020	There shall be no requirement for an ICAO operated core network or router.
UR49	c4 t 0030	High availability shall be assured with no single point of failure.
UR50	c4 t 0040	An ATN Inter-domain routing information protocol shall support the use of consistent distance metrics, QOS metrics and security information.
UR51	c5 t 0020	The ATN shall provide a common communications service for all ATSC and AISC applications that require either ground/ground or air/ground data communications services.
UR52	c5 t 0030	The ATN shall integrate and use existing communications networks and infrastructure wherever possible.
UR53	c5 t 0040	The ATN shall provide a communications service which meets the security and safety requirements of ATSC and AISC applications.
UR54	c5 t 0050	The ATN shall accommodate the different grades of service required by each ATSC and AISC application.
UR55	c5 t 0060	The ATN shall provide its users with a robust and reliable communications service, together with the option of a datagram service.

UR56	c5 t 0070	The ATN itself shall not make any demands on the syntax or semantics of the data carried in a CLNP packet.
UR57	C5 t 0080 - 0100	For data conveyed by an ATN Transport Connection, the QoS requirements are: i. Transit Delay shall be better than *tba* ii. Throughput shall be better than *tba* iii. The residual error rate shall be better than *tba* iv. Availability shall be better than *tba*
UR58	c5 t 0110	ATN interconnections shall be coordinated on both a regional and worldwide basis, so that ATN backbones (of Routing Domains offering general transit facilities) may be created, with either a clear apportionment of costs, or a known tariff, for use of use of transit facilities.
UR59	c5 t 0120	The ATN shall support 'mobile' subnetworks. Examples of such subnetworks include SSR Mode S, AMSS and VDL.
UR60	c5 t 0120	If an aircraft were to attach to one mobile subnetwork only and never to any other, then even though sometimes it may be attached and at other times not attached, this shall be of no consequence for the ATN.
UR61	c5 t 0120	The ATN shall support aircraft simultaneously attached to many different mobile subnetworks.
UR62	a5 n 0010	The ATN shall be capable of operating in a multinational environment with different data communication service providers.
UR63	a5 n 0010	The ATN shall be capable of supporting ATSC as well as AISC.
UR64	a5 n 0020	The ATN shall be capable of supporting the interconnection of End Systems and Intermediate Systems using a variety of subnetwork types.
UR65	a5 n 0020	The organisation of the ATN supported by system management shall aim for an optimisation of the communication resources available.

4. Recommendations

The working group is recommended to:

a) Review the User Requirements presented in this paper.

b) Forward the material for further consideration by Working Group 1

c) Incorporate the reformulated User Requirements in the draft ATN SARPs.

Appendix A - Classified List of Perceived User Requirements

Mark-up Reference	Requirement Text	Extracted From	Page Number	Replaced by
a5 n 0010	Note 1.- The ATN is capable of operating in a multinational environment with different data communication service providers. The ATN is capable of supporting ATSC as well as AISC.	A5.1	A5-1	UR62, UR63
a5 n 0020	Note 2.- The ATN is capable of supporting the interconnection of End Systems and Intermediate Systems using a variety of subnetwork types. The organisation of the ATN supported by system management aims for an optimisation of the communication resources available.	A5.1	A5-1	UR64, UR65
c1 t 0010	In order to fully utilise automated air traffic management (ATM) systems, a global data networking infrastructure must be implemented which supports the internetworking of state-of-the-art computer systems operating in fixed ground-based and mobile aircraft-based locations.	1.1	1-1	UR1
c1 t 0020	The key to success in developing and implementing this new internetwork infrastructure is the recognition that:	1.1	1-1	UR1
c1 t 0030	a) increased use of distributed ATM automation requires an increased level of computer-to-computer data communication, including data communication between aircraft-based and ground-based computers serving fixed and mobile users;	1.1	1-1	UR1
c1 t 0040	b) increased levels of distributed ATM automation require a more richly connected and more flexibly configured data network infrastructure than exists today, both in aircraft-based and ground-based environments;	1.1	1-1	UR1
c1 t 0050	c) real success in ATM automation can only be achieved when aircraft-based computer systems are designed and implemented as data processing and networking peers to their respective ground-based computers, rather than continuing in their current role as aircraft terminals attached to ground-based hosts.	1.1	1-1	UR1
c2 t 0060	The international aviation community is expected to adhere to the separation of communication functions as specified in the Open Systems Interconnection (OSI) Reference Model developed by the International Organisation for Standardisation (ISO).	2.1	2-1	UR5
c2 t 0040	The operational requirements for a future ATS system should be developed on the basis of a framework of an operational ATS concept. The operational requirements will allow the definition of a detailed functional specification of the ATC system, identifying the necessary ATS functions with related aeronautical applications.	2.1	2-1	UR2
c2 t 0080	Although all four aeronautical user groups can be supported by the ATN, there may be administrative and technical provisions to inhibit user groups from gaining access to certain subnetworks. For example, the SSR Mode S subnetwork will only carry communications related to safety and regularity of flight.	2.1	2-1	UR3, UR4
c2 t 0150	The principles necessary to satisfy the above objectives include the following:	2.2.2.1	2-2	
c2 t 0160	the ATM system should offer to its users the maximum flexibility in airspace utilisation, taking into account their operational and economic needs, as well as the ground capabilities. These capabilities may be constrained by airport capacity;	2.2.2.1	2-2	O/S
c2 t 0170	functional compatibility of the data exchanged between the airborne and the ground components is essential to ensure the global efficiency of the system;	2.2.2.1	2-2	UR6

c2 t 0180	the sharing of airspace between different categories of users must be organised as flexibly as possible, considering different levels of aircraft equipage;	2.2.2.1	2-2	O/S
c2 t 0190	the various ATC components of the over-all systems must be designed to work together effectively to ensure a homogeneous, continuous and efficient service to the user from take-off to landing. International harmonisation, and ultimately integration, is needed to provide for consistency in operations across national boundaries.	2.2.2.1	2-2	UR7
c2 t 0200	The realisation of a system capable of satisfying the above principles will require the adaptation of existing procedures and facilities as well as the development of new ones.	2.2.2.1	2-2	UR8
c2 t 0210	The improvements in airborne and ground systems capabilities will be used in a complementary fashion to maximise the efficient use of airport and airspace resources. In this respect the foreseen implementation of an air-ground data link will play an essential role. For the ground system, the following directions for change are envisaged:	2.2.2.3	2-3	UR9-UR13
c2 t 0220	a) improved handling and transfer of information between operators, aircraft and ATC centres;	2.2.2.3	2-3	UR9
c2 t 0230	b) improved and more accurate planning, including use of improved weather information;	2.2.2.3	2-3	UR10
c2 t 0240	c) improvement in conflict detection and resolution;	2.2.2.3	2-3	UR11
c2 t 0250	d) improvement in the ability to take advantage of the improved navigation accuracy in four dimensions of modern aircraft;	2.2.2.3	2-3	UR12
c2 t 0260	e) improved accommodation of a flight's preferred profile in all phases of flight, based on operator's objectives.	2.2.2.3	2-3	UR13
c2 t 0270	The evolution will have to take place within an environment which puts a number of constraints and conditions on the process, in particular:	2.2.2.3	2-3	UR14-19
c2 t 0280	a) a future system can only be implemented by means of an evolutionary process;	2.2.2.3	2-3	UR14
c2 t 0290	b) pilots and air traffic controllers must be kept involved in the ATC process;	2.2.2.3	2-3	UR15
c2 t 0300	c) the new system should not be overly sensitive to random disturbances, such as outages, emergencies, errors in forecasting, etc.;	2.2.2.3	2-3	UR16
c2 t 0310	d) improvements in weather forecasting may take longer to achieve than other improvements in over-all system performance;	2.2.2.3	2-3	UR17
c2 t 0320	e) although the system must be designed to accommodate normal peak traffic demands, and should be easily expanded to meet anticipated future growth, it is accepted that it may not be practicable to provide for excessive peak levels of air traffic demand.	2.2.2.3	2-3	UR18, UR19
c2 t 0420	Because of the differences in the level of air traffic management in the various parts of the world, and the variety of factors that influence transition to the future CNS system, an evolutionary development of air navigation for international civil aviation over a period of the order of 25 years.	2.2.2.3	2-4	UR20
c2 t 0560	All the above AOC functions need to interface with the aircraft via adequate air-ground communications (voice and data), either through cockpit crew intervention or directly with some airborne sensors and systems (after data verification by the cockpit crew) such as flight management systems (FMS) or digital flight data acquisition unit (DFDAU) for functions such as: a) FMS operational data base update on:	2.2.3	2-5	UR21

	1) flight plan data; 2) load and balance data; 3) certain weather data; and b) DFDAU recording of/reporting on: 1) engine health monitoring; 2) fuel flow/status/requirements; etc.			
c2 t 0600	All applications requiring support of the ATN must follow the same standardised set of rules to assure that all messages are delivered as efficiently as possible and in the correct order of priority.	2.3.1	2-5	UR22
c2 t 0720	The network will determine the transfer sequence of the provided end-user messages/files, on the basis of required priority (QOS parameter).	2.3.2.3.3	2-7	UR23
c2 t 0730	This priority will be indicated during the connection establishment phase.	2.3.2.3.3	2-7	UR24
c2 t 0740	Two types of priorities can be distinguished:	2.3.2.3.3	2-7	UR25
c2 t 0750	a) Static priority. The static priority is related to the type of information that has to be transferred via the ATN as with any other communications network. Article 51 of the ITU Radio Regulations gives the order of priority for ten information categories in the aeronautical mobile service and aeronautical mobile satellite service as follows:	2.3.2.3.3	2-7	UR26
c2 t 0760	1. Distress calls, distress messages and distress traffic.	2.3.2.3.3	2-7	UR26
c2 t 0770	2. Communications preceded by the urgency signal.	2.3.2.3.3	2-7	UR26
c2 t 0780	3. Communications relating to radio direction-finding.	2.3.2.3.3	2-7	UR26
c2 t 0790	4. Flight safety message.	2.3.2.3.3	2-13	UR26
c2 t 0800	5. Meteorological messages.	2.3.2.3.3	2-13	UR26
c2 t 0810	6. Flight regularity messages.	2.3.2.3.3	2-13	UR26
c2 t 0820	7. Messages relating to the application of the United Nations Charter.	2.3.2.3.3	2-13	UR26
c2 t 0830	8. Government messages for which priority has been expressly requested.	2.3.2.3.3	2-13	UR26
c2 t 0840	9. Service communication relating to the working of the telecommunication service or to communications previously exchanged.	2.3.2.3.3	2-13	UR26
c2 t 0850	10. Other aeronautical communications.	2.3.2.3.3	2-13	UR26
c2 t 0870	All the links in the communication network must be able to determine and to provide the communication service related to the required priority.	2.3.2.3.3	2-13	UR28
c2 t 0880	b) Dynamic priority. The dynamic priority is related to the situation in which certain information has to be transferred. For example, it is possible that in a short term conflict alert situation a heading instruction message (if that results in better resolution) has a higher priority than in a normal situation.	2.3.2.3.3	2-13	UR27
c2 t 1020	The use of the QOS parameters plus the network operating assumptions listed below allow the end user to be unaware of the particular delivery method(s) used by the ATN to effect data transfer:	2.3.2.5	2-15	UR29
c2 t 1030	a) the ATN can deliver messages of arbitrary length. It does this by segmenting and combining the messages as necessary to match the maximum	2.3.2.5	2-15	UR29

	data transfer size used by the individual subnetworks in the ATN;			
c2 t 1040	b) the ATN delivers data in a reliable manner. The user can assume that once the data is accepted by the ATN it will be delivered. The user will be informed if delivery is not possible;	2.3.2.5	2-15	UR29,UR30
c2 t 1050	c) the end user need not specify the route required to reach the destinations. This means that the ATN will maintain dynamic routing tables which reflect the current connectivity status;	2.3.2.5	2-16	UR29
c2 t 1060	d) the ATN only requires address information, the end-user data and the specified QOS parameters to perform its functions.	2.3.2.5	2-16	UR29
c3 t 0060	In order to realise the advantages of an internetwork architecture, techniques for transfer of messages among participating subnetworks must be independent of protocols and addressing schemes internal to any one participating subnetwork.	3.2	3-1	UR31
c3 t 0070	This means that all participating subnetworks must be interconnected via internetwork routers observing common internetworking conventions and standards.	3.2	3-1	UR32
c3 t 0080	The requirements placed upon these subnetworks and their interconnecting routers may be summarised as follows:	3.2	3-1	UR33 - UR36
c3 t 0090	a) all participating routers must utilise a common internetwork protocol standard, including a common definition of QOS parameters;	3.2	3-1	UR33
c3 t 0100	b) all participating routers must exchange routing information using a common routing information exchange protocol standard;	3.2	3-1	UR34
c3 t 0110	c) all participating routers must utilise a common global network addressing standard;	3.2	3-1	UR35
c3 t 0120	d) all interconnecting subnetworks must carry the internet protocol, routing protocol and global addressing formats between adjacent routers in a transparent fashion.	3.2	3-1	UR36
c3 t 0170	The ISOPA demands that a uniform level of network service be presented to all transport layer processes at this boundary; this requires that a single network layer service interface be adopted throughout a given domain, supported by a common internetwork protocol.	3.3.2	3-3	UR37
c3 t 0430	The ATNPA is designed to employ any subnetwork technology capable of code and byte independent delivery of data as a constituent subnetwork.	3.8.1	3-6	UR38
c3 t 0440	The most significant requirement placed on these constituent subnetworks is that they must provide at least connectionless-mode subnetwork service.	3.8.1	3-6	UR39
c3 t 0450	While only connectionless-mode subnetwork service is required, a connection-mode subnetwork may be utilised through the implementation of the appropriate convergence function.	3.8.1	3-6	UR39
c3 t 0580	The interconnected ATN host computers and routers administered by international authorities for aeronautical data communication comprise the ATN common domain. The ATN common domain encompasses all data communication service end users associated with the international civil aviation environment.	3.10	3-7	UR40
c3 t 0780	The most significant performance objective of a hierarchical routing architecture is the minimisation of routing information transfer between administrative/routing domains at the inter-domain level, and between routing areas at the intra-domain level	3.12.1	3-10	UR41
c3 t 1050	The ATN subnetwork sublayer must support the transparent transfer of NPDUs between adjacent internetwork entities. This includes the transparent transfer of global addresses and quality of service information, as well as user	3.15.1	3-13	UR42

	data.			
c3 t 1060	The functional requirements imposed upon a participating ATNPA subnetwork may be summarised as follows:	3.15.1	3-13	UR43-UR46
c3 t 1070	a) the subnetwork interface to the internet (i.e. router) occurs within the network layer, thus control information for the data link and physical layers is not passed from subnetwork to subnetwork. Hence, the subnetwork may utilise non-conforming protocols within these layers while maintaining ISOPA conformance within the network layer;	3.15.1	3-13	UR43
c3 t 1080	b) the subnetwork places no restrictions on the form or content of the upper layer headers, but simply transfers the control information for these layers without modification;	3.15.1	3-13	UR44
c3 t 1090	c) the subnetwork must carry ISO networkPCI for evaluation by each intervening router (i.e. intermediate system);	3.15.1	3-14	UR45
c3 t 1100	d) the subnetwork must transparently transfer standard global network address (i.e. ISO NSAP) and quality of service information, for evaluation by each intervening router.	3.15.1	3-13	UR46
c4 t 0010	The ATN must be able to function such that each participating administration and service provider can operate ATN Routing Domains, and interconnect, without requiring that some administrations and service providers are more special than others.	4.1.1	4-2	UR47
c4 t 0020	There must not be a requirement for, for example, an ICAO operated core.	4.1.1	4-2	UR48
c4 t 0030	High availability is essential and the existence of any single point of failure is unacceptable.	4.1.1	4-2	UR49
c4 t 0040	Such a protocol must enable the use of consistent distance metrics, QOS metrics and security information.	4.1.1	4-2	UR50
c5 t 0010	The ATN is a data communications internetwork that:	5.1.1	5-1	UR51-
c5 t 0020	1. provides a common communications service for all ATSC and AISC applications that require either ground/ground or air/ground data communications services.	5.1.1	5-1	UR51
c5 t 0030	2. integrates and uses existing communications networks and infrastructure wherever possible.	5.1.1	5-1	UR52
c5 t 0040	3. provides a communications service which meets the security and safety requirements of ATSC and AISC applications.	5.1.1	5-1	UR53
c5 t 0050	4. accommodates the different grades of service required by each ATSC and AISC application.	5.1.1	5-1	UR54
c5 t 0060	The ATN provides its users with a robust and reliable communications service, together with the option of a datagram service.	5.1.1.1	5-1	UR55
c5 t 0070	The ATN itself does not make any demands on the syntax or semantics of the data carried in a CLNP packet. However, the simplicity of the service does carry a penalty and this is that delivery of datagrams is not guaranteed. When a user transfers an ISO 8473 formatted packet to an ATN Router, that user is only guaranteed a probability of delivery dependent on the data priority. The probability of delivery is high, and while no targets have yet been set for delivery probability, 97% - 98% is certainly realistic.	5.1.1.1	5-3	UR56
c5 t 0080	Considerations that affect this figure include: 1. the error rates on subnetworks such as Ethernets which may lose data in transit due to line errors (although this consideration does not apply to X.25 subnetworks and similar examples, which provide a reliable transfer service)	5.1.1.1	5-4	UR57

	2. network overload which results in low priority data being discarded in order to free up congested resources 3. component failures.			
c5 t 0090	The actual delivery probability that is provided is a design issue. Once actual targets have been provided then it is possible to design a network to meet the requirement. This is achieved by minimising the use of lower reliability subnetworks, increasing overall network capacity, and through component redundancy.	5.1.1.1	5-4	UR57
c5 t 0100	However, the network can never provide a 100% delivery probability. When an ATN user does require reliable data transfer, then the end to end ISO 8073 class 4 transport protocol is required, in addition to the CLNP. This protocol itself uses CLNP packets to convey information between ATN users. The protocol can detect data loss and recovers from it by retransmission. It can also provide end to end flow control and multiplexing of different data streams between the same pair of users. When this protocol is used, the impact of a comparatively low delivery probability is on mean transit delay (the average time it takes to transfer data from source to destination). This is because recovery from data loss is by retransmission, and hence the lower the delivery probability, the longer the mean transit delay. There is hence a need to offset the impact of an increased mean transit delay against the cost and design implications of higher delivery probability.	5.1.1.1	5-4	UR57
c5 t 0110	Instead, it is intended that ATN interconnections are coordinated on both a regional and worldwide basis, so that ATN backbones (of Routing Domains offering general transit facilities) are created, with either a clear apportionment of costs, or a known tariff, for use of use of transit facilities. This way users can gain access to the full capabilities of the ATN quickly and cheaply.	5.1.1.2	5-5	UR58
c5 t 0120	The ATN will incorporate many 'mobile' subnetworks. Examples of such subnetworks include SSR Mode S, AMSS and VDL. If an aircraft were to attach to one mobile subnetwork only and never to any other, then even though sometimes it may be attached and at other times not attached, this has no consequence for the ATN. This is because from the point of view of the rest of the ATN, it would be no different from a fixed system that was occasionally off-line. However, that is not how mobile subnetworks are used. An aircraft will attach to many different mobile subnetworks during the course of its flight. A long haul aircraft may move between the coverage areas of different satellites; an aircraft flying over a land mass will fly between different Mode S subnetworks as it passes over different countries. And, at the same time, the applications on board the aircraft will need to maintain contact with applications on the ground. Mobile platforms thus require special routing considerations.	5.1.1.3	5-5	UR59-UR61
c5 t 0130	In the ATN, mobile 'platforms' are treated in a similar manner as organisational users. That is, the systems on board an aircraft are required to form a Routing Domain and hence must include an ATN Router that is also a BIS. This is partly because the ISO/IEC 10747 routing protocol provides a relatively efficient mechanism for the transfer of routing information over low bandwidth links, but also because aircraft are almost always organisationally separate to the ground systems with which they are in contact and the same requirements for policy based routing apply.	5.1.1.3	5-6	N/A
c5 t 0140	This strategy is based on the notion of an aircraft's 'home'. The 'home' of an aircraft does not necessarily relate to an airline's headquarters, its maintenance facilities, or indeed any geographical concept of 'home'. It is simply a particular ATN Routing Domain, and, in principle, any ATN RD will do. It may be an RD belonging to an aircraft's airline, but equally it may belong to a Service Provider or an Administration. Typically, all aircraft belonging to the same airline, or the General Aviation (GA) aircraft of a single country share the same home. Through the ISO/IEC 10747 routing protocol, a route to an aircraft's home is known throughout the fixed ATN.	5.1.1.3	5-6	N/A
c5 t 0150	ATN subnetworks are those subnetworks interconnecting ATN ISs and ESs for the purpose of transferring data between these components. The ATNPA is designed to employ any subnetwork technology capable of code and byte independent delivery of data. The most significant requirement placed on these subnetworks is that they must provide at least a connectionless-mode service. While only the connectionless mode service is required for data transfer, a connection mode subnetwork may be used if the required service is provided	5.2.3	5-12	UR39

	through an appropriate convergence function			